

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

a semiconductor substrate;

a metal film disposed on said semiconductor substrate;

and

5 a diffusion barrier film covering an upper surface of said metal film,

wherein said diffusion barrier film comprises an insulating material containing silicon, carbon, hydrogen and nitrogen as constituent elements, and wherein said insulating
10 material contains Si-H bond, Si-C bond and methylene bond (-CH₂-).

2. The semiconductor device as set forth in claim 1, wherein an infrared absorption spectrum of said insulating material includes:

I_2/I_1 of not lower than 0.067;

5 where I_1 is defined as an absorption area of an infrared absorption band having a peak near 810 cm⁻¹, and

I_2 is defined as an absorption area of an infrared absorption band having a peak near 2,120 cm⁻¹.

3. The semiconductor device as set forth in claim 1, wherein an infrared absorption spectrum of said insulating material includes:

I_3/I_1 of not higher than 0.0067;

5 where I_1 is defined as an absorption area of an infrared absorption band having a peak near 810 cm⁻¹, and

I_3 is defined as an absorption area of an infrared absorption band having a peak near 1,250 cm⁻¹.

4. The semiconductor device as set forth in claim 2, wherein an infrared absorption spectrum of said insulating material includes:

I_3/I_1 of not higher than 0.0067;

5 where I_1 is defined as an absorption area of an infrared absorption band having a peak near 810 cm^{-1} , and I_3 is defined as an absorption area of an infrared absorption band having a peak near $1,250\text{ cm}^{-1}$.

5. The semiconductor device as set forth in claim 1, wherein said metal film contains copper as a main constituent.

6. The semiconductor device as set forth in claim 2, wherein said metal film contains copper as a main constituent.

7. The semiconductor device as set forth in claim 3, wherein said metal film contains copper as a main constituent.

8. The semiconductor device as set forth in claim 4, wherein said metal film contains copper as a main constituent.

9. A method for manufacturing a semiconductor device, comprising:

forming a first insulating film on a semiconductor substrate;

5 selectively removing said first insulating film to form an interconnect trench;

filling said interconnect trench with a metal to form a metal film; and

10 depositing a diffusion barrier film including an insulating material containing silicon, carbon, hydrogen and nitrogen as constituent elements to cover the upper surface of said metal film,

wherein said depositing said diffusion barrier film is conducted by a plasma CVD utilizing a source gas containing:

15 (a) trimethylsilane or tetramethylsilane; and

(b) a nitrogen-containing compound,

and wherein a pressure during said depositing said diffusion barrier film is not higher than 4 Torr.

10. A method for manufacturing a semiconductor device, comprising:

forming a first insulating film on a semiconductor

substrate;

5 selectively removing said first insulating film to form
an interconnect trench;

 filling said interconnect trench with a metal to form a
metal film; and

 depositing a diffusion barrier film including an
10 insulating material containing silicon, carbon, hydrogen and
nitrogen as constituent elements to cover the upper surface of
said metal film,

 wherein said depositing said diffusion barrier film is
conducted by a plasma CVD utilizing a source gas containing:

15 (a) vinyl group-containing silane; and
 (b) a nitrogen-containing compound.

11. The method as set forth in claim 10, wherein said vinyl
group-containing silane is selected from the group consisting
of trimethylvinylsilane, dimethyldivinylsilane,
monomethyltrivinylsilane, and tetravinylsilane.